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Furrow Irrigation

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U.S. DEPARTMENT OF AGRICULTURE

FURROW IRRIGATION

By George A. Lawrence, *civil engineer, Southwest Region, Soil Conservation Service*

THE USE OF FURROWS for irrigating row crops is as old as irrigation itself. In furrow irrigation the water is applied by running small streams in ditches, or furrows, between crop rows. The water soaks into the soil and spreads out into the crop-root areas between furrows (figs. 1 and 2).

Furrows are made with various cultivating tools, depending on the crops grown. Crops like corn and potatoes have furrows between all rows. Bedded crops, such as lettuce, carrots, and onions, often have furrows only along each pair of rows. Wide-spaced crops—tomatoes, orchards, berries, and grapes—generally have more than one furrow between crop rows.

Uses and Limitations

You can use furrow irrigation satisfactorily on nearly all agricultural soils. Slope limits the size of the stream you may use without causing serious erosion. The kind and condition of your soil also limit the size of the furrow stream. For instance, the soil in a freshly cultivated furrow may erode easily. But whether your water-supply stream is large or small, furrow irrigation permits efficient use of the water.

Furrow Spacing

Usually, you space furrows to fit the crops you grow and the standard machinery used for planting and other operations. If the water does not spread to the sides into the ridge and root zone of the crop before it moves down below the root zone, you should reduce the distance between furrows. Or sometimes you can make two or more furrows between the crop rows. On uniform slopes of less than 0.5 percent, you can use wide, flat-bottom furrows. Avoid making furrows so deep that the plant roots are above the bottom of the furrow.

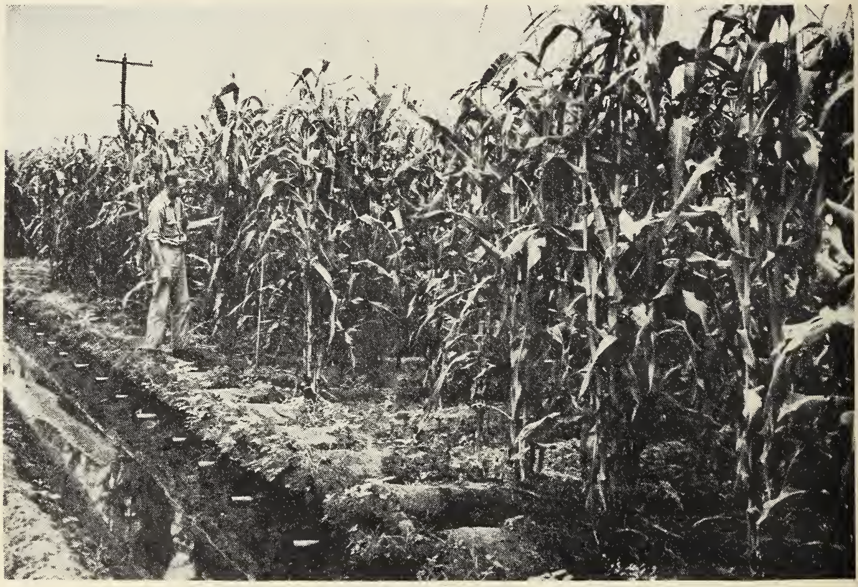

***Figure 1.*—Furrow irrigation of a cornfield. Spiles at the heads of furrows control distribution of water.**

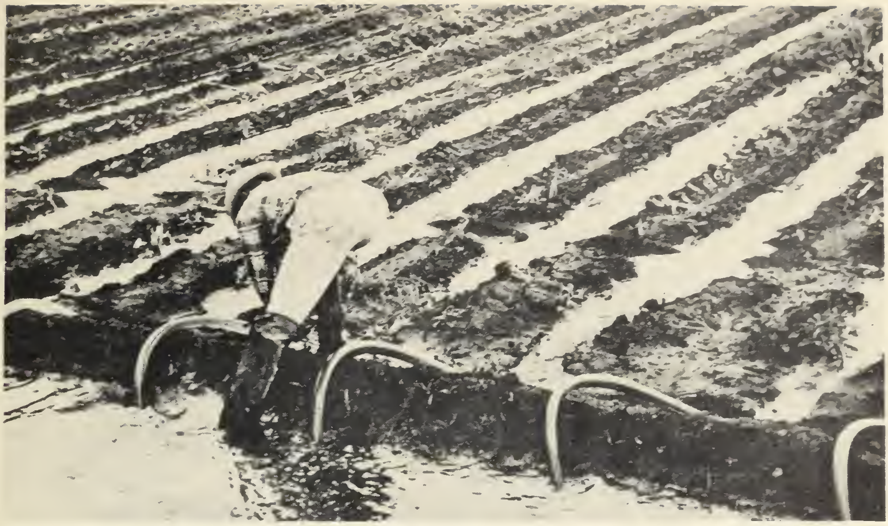

Figure 2.—**Plastic siphon tubes are being used to distribute water direct from head ditch on a farm in New Mexico.**

Effect of Slope

Experience has proved that a furrow slope of 2 percent and more may be too steep for furrow irrigation of cultivated crops. If you live in a high-intensity rainfall area, you may find that furrow slopes steeper than 0.25 percent (3-inch fall in 100 feet) are too steep.

You will generally find it profitable to prepare your land and arrange your fields for furrow slopes as nearly flat as soil depth and cost of smoothing, or "leveling," will permit. In some areas farmers use such extreme measures as "stockpiling" the topsoil, leveling the subsoil, and then spreading the stockpiled topsoil to make a uniform covering over the newly leveled field.

The rate that water is taken into your soil and the side spread of water into the crop ridge decreases as the furrow slope increases. You will get greater crop yields and save considerable irrigation labor costs if you can arrange your fields for furrow slopes of less than 1 percent.

Furrow slopes should be uniform for the full length of the furrow. If reshaping, or "leveling," to reduce the major slope of the field is not feasible, you should smooth the field to a uniform slope. The furrow slope can then be reduced by running diagonal furrows across the uniformly sloping field if the furrows are made large enough to prevent the irrigation water from breaking over the crop ridge. If the field slope cannot be made uniform or if the slope is steeper than 2 percent, contour furrows may be advisable. (See Leaflet 342, Contour-Furrow Irrigation.)

Amount of Water in Each Furrow

The size of stream you use in each furrow should be controlled to fit the slope of the furrow and the condition of your soil. You should use the largest possible stream that will not cause serious erosion (maximum nonerosive stream). The soil then absorbs water evenly through the entire furrow length. After the water reaches the lower end of the furrow, you should reduce the stream (cut-back stream). This way almost all of the water will be taken into the soil along the length of the furrow and very little will be wasted as runoff at the lower end. This is particularly true on clay and clay

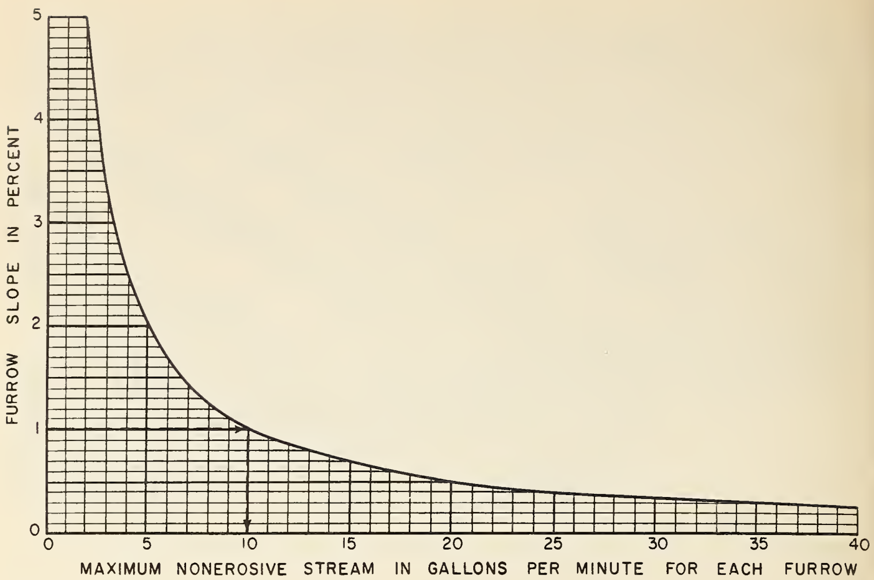

***Figure 3.*—Generalized relationship of furrow slope and maximum nonerosive stream on a loam soil with average organic matter.**

loam soils where the water must be run for a long time to get enough to the crop roots.

Figure 3 can help you decide how much water to use in each furrow. The total irrigation stream is usually divided among a certain number of furrows. As a rule, irrigation water is measured to the farm in cubic feet per second or in miners inches, which can easily be changed to cubic feet per second. One cubic foot per second gives 450 gallons per minute. Therefore, 1 cubic foot per second divided among 60 furrows would be 7½ gallons per minute for each furrow; but 1 cubic foot per second divided among 15 furrows gives 30 gallons per minute for each furrow.

Assume that you are ready to furrow irrigate a row crop. You have measured the furrow slope with a farm level and it is 1 percent. You have available 1 cubic foot per second (450 gallons per minute) of water measured near the field. About how many furrows should you turn this water into?

For the answer, find the 1-percent mark on the left side of figure 3. Then move to the right from this point to the curve. From the point on the curve, move down to the horizontal scale. The reading is 10 gallons per minute for each furrow. You have 450 gallons per minute in all so you can turn the water into 45 furrows (450 divided by 10 is 45).

Figure 3 applies to a loam soil with average organic matter. Your soil may be a more erosive soil; therefore, you must check on the stream in your soil by looking for soil washing as the water runs down the furrows. On slopes of 0.5 percent or less, it may be that you can safely use large streams in each furrow. Small furrows, however, may prevent you from using large streams. On slopes steeper than 3 percent the maximum nonerosive stream is so small that extraordinary control is necessary.

Length of Run

Your crop rotation will influence the length of run. Each field layout should provide for satisfactory lengths of run for any irrigation method (furrow, corrugation, and border) that may be used in successive years. (See Leaflets 297 and 343.)

The soil, the slope of the field, and the size of the stream are the major factors in deciding on the length of run for furrows. A shorter length of run must be used on porous sandy soils than on tight clay soils on the same slope. If you decrease the furrow slope by land "leveling" or by angling the rows across a uniformly sloping field, you can make the runs longer. This is possible because the flatter the slope, the larger the maximum nonerosive stream; and the larger the stream, the faster its flow to the end of the furrow.

Runs should not be laid out over two strikingly different kinds of soil. For example, where a sandy loam soil merges into a clay loam, you should plan to irrigate the two kinds of soil as separate fields.

You should consider the overall length of the field when dividing it into separate fields with two or more equal or different lengths of run. The difficulty in turning equipment at the ends of the rows should be considered, but don't forget the value of a good layout and its effect on soil fertility and continued crop production.

Use figure 3 for making an estimate *only* of the maximum nonerosive stream. You should make a trial irrigation on several furrows, using a different size of stream in each furrow, to determine the maximum nonerosive stream. You can get information for the length of run at the same time by having 100-foot distances marked along the furrow and by making a record of the time it takes the water to flow each 100 feet.

You will find that the maximum nonerosive stream will require a longer time to flow through each successive 100 feet down the furrow. If the length of run is too long, you will get percolation that is too deep at the head of the furrow by the time the water reaches the end of the run. During the trial irrigation, check how far the water spreads into the root area as well as how deep the water goes.

For most crops, you apply more irrigation water at the height of the

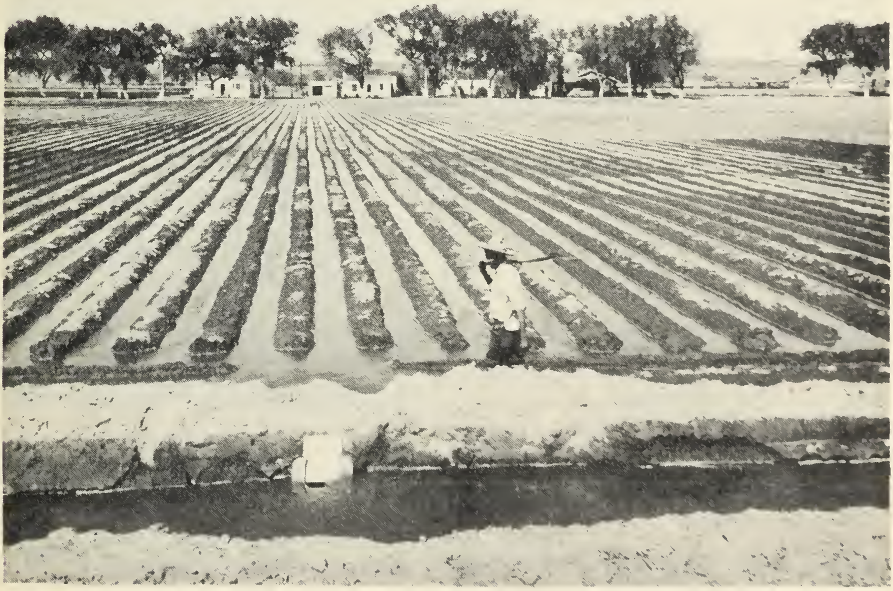

Figure 4.**—On level land, a turnout box in the equalizing ditch can be used to distribute water to the furrows.**

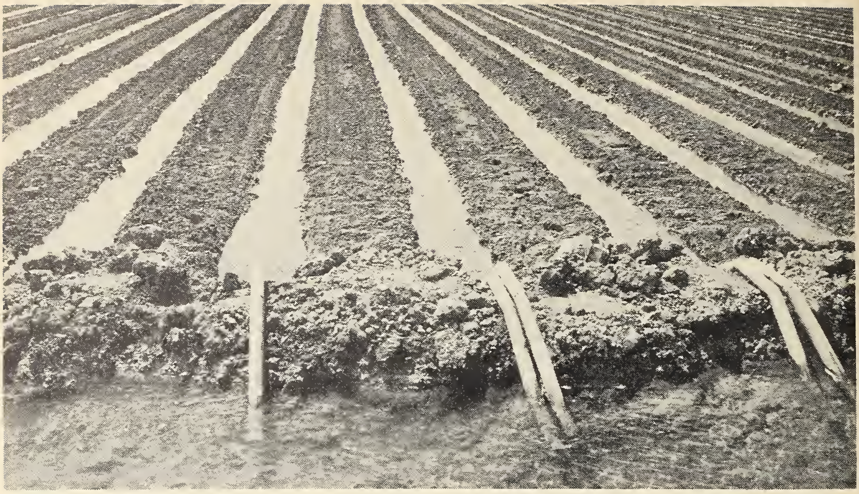

Figure 5.—**Galvanized metal siphon tubes being used to distribute water direct from head ditch on a farm in Lompoc Valley, Calif.**

growing season than at any other time. The length of run is correct if the maximum nonerosive stream reaches the end of the furrow—and needs to be cut back—in about one-fourth the time it takes to irrigate the crop at this season. On slopes of less than 0.2 percent this rule of thumb may not apply. On such flat slopes you may not need to cut back the stream at all. It is often possible to pond enough water in a large furrow to complete the irrigation without using the cut-back stream. The needed amount of water is ponded in the furrow much the same as it is in basin irrigation.

Once you have the field laid out and the crop growing, the job of irrigating becomes one of applying the water properly. The ideal layout is no guarantee that you will get an efficient irrigation. You need to know the amount of water in the soil before irrigation and the amount of water needed to fill the soil to its water-holding capacity. You should check moisture penetration with a soil auger, probe, or shovel 1 or 2 days after, as well as during, the irrigation. You save natural resources—soil, water, and plant food—by applying water uniformly and efficiently to the land.

Control and Distribution of Water

The following methods for control and distribution of water in furrow irrigation are considered good:

Field lateral with equalizing ditch.—If your field is level, you can use an equalizing ditch to distribute water to the furrows (fig. 4). Since the furrows have no slope, the water levels out from the equalizing ditch. It is ponded by dams at the end of furrows and allowed to soak into the soil.

Field lateral with equalizing ditch and spiles.—If the furrow slope is greater than 0.2 percent, spiles can be used to control the water delivery from the equalizing ditch to individual furrows (fig. 1). Spiles are straight tubes made of wood, metal, plastic, rubber, or concrete. Discarded air-hose railroad-car couplings make good spiles. They should be large enough to deliver the maximum nonerosive stream when the ditch water surface is about 6 inches over the spile opening.

Field lateral direct to furrow through spiles.—If the slope of your head ditch is nearly flat, an equalizing ditch is not necessary. You can set spiles in the bank of the head ditch itself. Permanent spiles can be installed dead level for each section of level ditch.

The water surface in each ditch section can be controlled by a check gate. It should be held high enough above the center of the spile opening to deliver the maximum nonerosive stream until the water reaches the end of the run. Then lower it to a point that will deliver the right cut-back stream through the spiles. Permanent spiles are not recommended unless you have plenty of hand labor to keep your ditches clean and free of weeds.

Field lateral direct to furrow through siphon tubes.—Siphon tubes made of metal, rubber, or plastic (fig. 5) can also be used to distribute water direct from the head ditch to the furrows. The tubes are made in various sizes. Two or more small tubes are often used for each furrow until the water reaches the lower end. To cut back the stream, remove one or more of the tubes, or use a smaller tube.

Gated surface pipe.—A gated surface pipe can be used to carry water to the furrows (fig. 6). The small gates (spaced to match furrow spacing) in this pipe can be adjusted to control the flow of water into the individual furrows. The pipe is made in lightweight sections that are easily coupled together. Using gated surface pipe eliminates weed problems common to the open-field lateral. It also permits cultivation through several lengths of run since the pipe may be uncoupled and laid parallel to the rows or removed from the field during cultivation.

Surface hose with distribution sections.—A vinyl-coated glass-cloth or canvas hose may be used to distribute water to the furrows. Each section is fitted with outlet tubes, spaced according to the width of the furrows. This method is comparatively new, but has been used in some areas. This hose usually comes in 100-foot lengths that you can roll up and carry from field to field.

Buried pipeline and risers.—A distribution system consisting of buried pipelines with risers ending in distribution pots has been used successfully in orchards and vineyards (fig. 7).

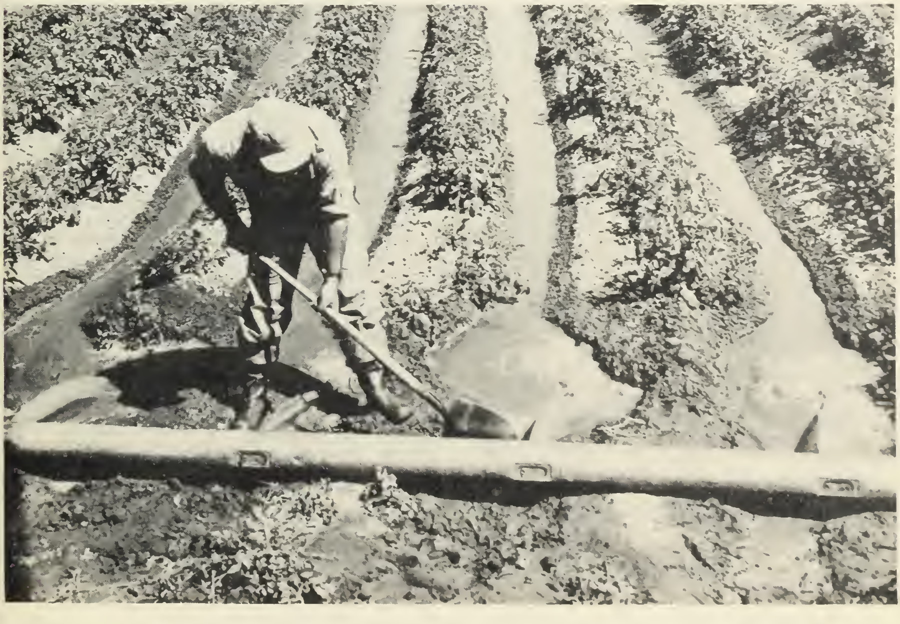

***Figure 6.*—Using gated surface pipe to control the flow of water to individual furrows in irrigating Idaho potatoes.**

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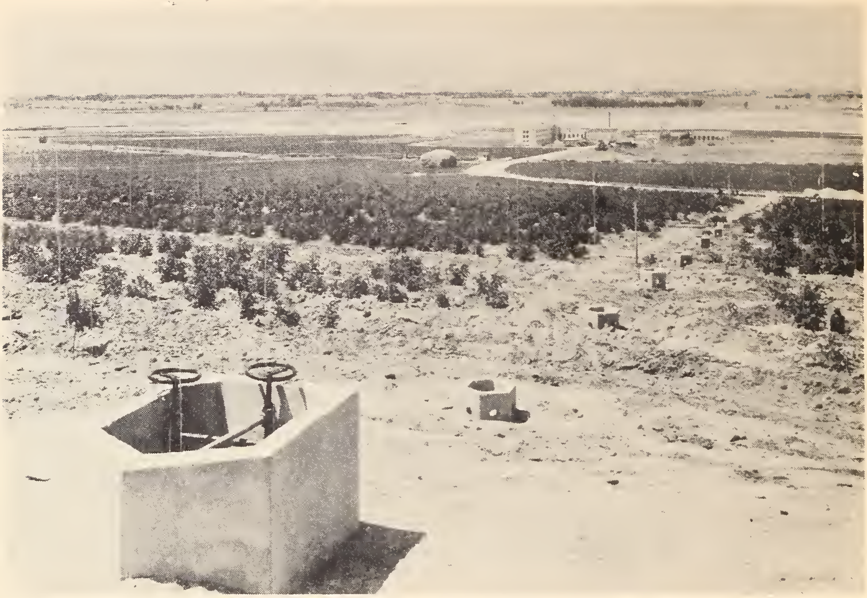

Figure 7.—**Buried pipeline, risers, and distribution pots being used for furrow irrigation of an orchard in Utah.**

Water is carried to the head of each furrow through a V-shaped trough or small pipe from each opening in the riser pot. You can get uniform distribution of water with this system. The depth of water in each riser pot is controlled by a valve. Equal depths of water in each pot means equal amounts of water delivered to each furrow. Buried pipelines and risers may be fitted with valves and metal hydrant caps to which you can connect one or more lines of gated surface pipe or hose.

Disposal of Runoff

With careful management, you will have very little runoff. You can eliminate runoff in level furrows by closing the ends of the furrows and ponding the water. To dispose of runoff at the end of furrows on sloping land, construct a small ditch to carry it safely from the field. This water should be used on a lower field to prevent waste.

Maintenance

Your irrigation system will not give good results unless you take care of it—and on time. You can help maintain uniform land slopes if you plan your plowing, cultivating, and harvesting carefully. The furrow size and shape best suited to your crop, soil, and slope should be carefully maintained with cultivation equipment to assure the best furrow-irrigation results.

Spiles, siphons, surface pipe, and structures are easily damaged by cultivating and harvesting equipment if they are not properly cared for.

Ditches must be kept clean. Structures must be kept in repair. If you have permanent spiles you usually need to hand-clean the ditches.

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